

Scotland's Rural College

## Early intervention with enrichment can prevent tail biting outbreaks in weaner pigs

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**Abstract:** Tail biting is a serious animal welfare problem in the modern pig production. A frequently studied preventive measure is enrichment materials, and increasing levels of enrichment materials, especially litter materials, reduces the risk of tail biting. However, permanent access to litter materials, can cause blockage of the slurry system and increase production cost. The aim of the present study was, therefore, to investigate if providing extra enrichment material, when observing the first tail damage could reduce the prevalence of tail biting outbreaks. The study included 1,804 weaner pigs from 7- 30 kg distributed in 60 pens with intact tails. As basic enrichment material, pens were equipped with two wooden sticks and daily provided with approximately 400 g of fine chopped straw. From outside the pen pigs were checked for tail damages three times weekly. When the first tail damage (fresh or scabbed) was recorded, the pen was assigned to one of four treatments; chopped straw (approximately 200 g/pen) on the floor (straw), haylage in a spherical cage (haylage), hanging rope with a sweet block (rope) or no extra material (control). From first treatment day and until a tail biting outbreak, tails were scored three times weekly. A tail biting outbreak occurred when four pigs in a pen had a tail damage, irrespective of wound freshness. The experiment was designed to compare the prevalence of tail biting outbreaks in each of the extra material group with the control group. A treatment was carried out in 44 of the 60 pens: 10 pens with straw, 8 pens with haylage, 7 pens with rope and 19 control pens. The risk of a tail biting outbreak was significantly lower in pens with haylage and straw compared with control pens ( $P < 0.05$ ), and there tended to be fewer tail biting outbreaks in rope-pens compared with control pens ( $P = 0.08$ ). The results should, though, be interpreted with caution due to the relatively small sample size. In control pens with no intervention, a tail biting outbreak developed in 42 % of the pens within two to five days after the first tail damage was observed, whereas a tail biting outbreak did not occur in 32% of the control pens. In conclusion, a regular tail inspection and the use of extra enrichment material, when the first minor tail damage occur, could be one way to reduce the prevalence of tail biting outbreaks.

## Highlights

- Providing extra enrichment as an early intervention reduced tail biting outbreaks
- Tail damage was observed among weaner pigs with intact tails in 58 of 60 pens
- Solitary tail damage did occur without escalating into tail biting outbreaks

# 1 Early intervention with enrichment can prevent tail biting outbreaks in weaner pigs

2

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15 Short title: Early intervention prevents tail biting outbreak

16

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## 21    **Abstract**

22    Tail biting is a serious animal welfare problem in the modern pig production. A frequently  
23    studied preventive measure is enrichment materials, and increasing levels of enrichment  
24    materials, especially litter materials, reduces the risk of tail biting. However, permanent  
25    access to litter materials, can cause blockage of the slurry system and increase production  
26    cost. The aim of the present study was, therefore, to investigate if providing extra  
27    enrichment material, when observing the first tail damage could reduce the prevalence of  
28    tail biting outbreaks. The study included 1,804 weaner pigs from 7- 30 kg distributed in 60  
29    pens with intact tails. As basic enrichment material, pens were equipped with two wooden  
30    sticks and daily provided with approximately 400 g of fine chopped straw. From outside the  
31    pen pigs were checked for tail damages three times weekly. When the first tail damage  
32    (fresh or scabbed) was recorded, the pen was assigned to one of four treatments;  
33    chopped straw (approximately 200 g/pen) on the floor (straw), haylage in a spherical cage  
34    (haylage), hanging rope with a sweet block (rope) or no extra material (control). From first  
35    treatment day and until a tail biting outbreak, tails were scored three times weekly. A tail  
36    biting outbreak occurred when four pigs in a pen had a tail damage, irrespective of wound  
37    freshness. The experiment was designed to compare the prevalence of tail biting  
38    outbreaks in each of the extra material group with the control group. A treatment was  
39    carried out in 44 of the 60 pens: 10 pens with straw, 8 pens with haylage, 7 pens with rope  
40    and 19 control pens. The risk of a tail biting outbreak was significantly lower in pens with  
41    haylage and straw compared with control pens ( $P<0.05$ ), and there tended to be fewer tail  
42    biting outbreaks in rope-pens compared with control pens ( $P=0.08$ ). The results should,  
43    though, be interpreted with caution due to the relatively small sample size. In control pens  
44    with no intervention, a tail biting outbreak developed in 42 % of the pens within two to five

45 days after the first tail damage was observed, whereas a tail biting outbreak did not occur  
46 in 32% of the control pens. In conclusion, a regular tail inspection and the use of extra  
47 enrichment material, when the first minor tail damage occur, could be one way to reduce  
48 the prevalence of tail biting outbreaks.

49

50 Keywords: pigs, tail biting, tail damage, enrichment material

## 51 1. Introduction

52 Tail biting is a major animal welfare and [economic](#) problem, which remains prevalent in  
53 modern pig production (D'Eath et al., 2016). To prevent or reduce the level of tail biting, a  
54 series of different actions have been implemented. One of the most common preventive  
55 measures is tail docking which decreases the risk of tail biting (Lahrmann et al., 2017;  
56 Larsen et al., 2017). Tail docking is, however, a controversial solution to the problem since  
57 there is ample evidence that the tail docking procedure itself is painful (Herskin et al.,  
58 2016), and since the long-term effect is less well [documented](#) (Di Giminiani et al., 2017).  
59 Although routine tail docking is prohibited in the EU, it is still common (D'Eath et al., 2016).  
60 The European Commission is working to decrease the number of tail docked pigs and  
61 subsequently has published guidelines to member states on how to reduce routine tail  
62 docking by improving housing systems and management routines (EC, 2016). Because of  
63 the welfare issue and increased focus on ceasing routine tail docking, it is essential to find  
64 alternative solutions to the tail biting problem.

65 An additional reason for reducing the use of tail docking is that it does not eliminate  
66 the underlying problems causing the tail biting behaviour (Sutherland and Tucker, 2011).  
67 [Although the causation of tail biting is multifactorial and may include insufficient feeding](#)  
68 [space, poor nutrition, poor health etc. \(D'Eath et al., 2014\), a large proportion of studies on](#)  
69 [tail biting have investigated the effect of permanent access to loose enrichment materials](#)  
70 [in the prevention of tail biting outbreaks \(e.g. straw \(Zonderland et al., 2008\); compost](#)  
71 [\(Beattie et al., 2001\); alfalfa hay and corn silage \(Veit et al., 2016\)\)](#). These studies have  
72 [been conducted as lack of enrichment materials, which increase the risk of tail biting](#)  
73 [\(Schröder-Petersen and Simonsen, 2001; Taylor et al., 2010\)](#). Permanent access to litter  
74 materials such as compost and straw, however, [has](#) a number of disadvantages for the

75 farmers and will increase production costs due to extra labour and material expenditures  
76 (Tuytens, 2005). A recent survey of Swedish farmers also found that concerns about the  
77 perceived inability of the manure system to handle large amounts of straw was the main  
78 reason for not using more of it (Wallgren et al., 2016). An alternative may therefore be to  
79 give access to a material that does not block the manure system to the same extent as  
80 straw, e.g. rope or hay in a rack (D'Eath et al., 2014).

81         However, even these alternatives may be costly or labour intensive. Another  
82 approach could therefore be to give the more-costly, but more attractive, materials only  
83 when needed to prevent tail biting. [An attractive material, was in a review dealing with](#)  
84 [pigs' motivation to explore, defined as 'edible', 'changeable', 'destructible' and](#)  
85 ['manipulable' \(Studnitz et al., 2007\).](#) While only providing extra materials in pens where the  
86 first minor tail damage is detected may be less preferable than continuous access to the  
87 material, it has the advantage of being less costly/manageable for the farmer to handle  
88 and therefore may be more likely implemented.

89         Until recently, tail biting outbreaks have been notoriously difficult to predict. Recent  
90 studies have, however, demonstrated that tail postures change from curly to hanging prior  
91 to a tail biting outbreak (Zonderland et al., 2009; Lahrmann et al., 2018). Lahrmann et al.  
92 (2018), found that the change in tail posture was so pronounced that it would be possible  
93 for a farmer to use in daily health monitoring.

94         [To our knowledge, only one previous study has examined the effect of different](#)  
95 [interventions on tail damaged pigs in pens with a tail biting outbreak \(removing the biting](#)  
96 [pig or giving straw - \(Zonderland et al., 2008\)\).](#) No previous studies have examined  
97 provision of extra enrichment material as an early intervention, just when the first minor tail



98 damage is observed, to determine if this can reduce the tail biting behaviour and thereby  
99 prevent tail biting outbreaks. The aim of the current experiment was to investigate whether  
100 early interventions could prevent tail biting outbreaks in weaner pigs. It was hypothesized  
101 that providing straw, haylage in a spherical cage or sisal rope, when the first pig in a pen  
102 was observed with a tail damage, would reduce the occurrence of subsequent tail biting  
103 outbreaks. Further, we wanted to establish whether less than four weaners (< 14  
104 percentage of the pigs/ pen) with a tail injury was a sign of an upcoming tail biting outbreak  
105 within the next two to five days. Finally, we scored tail posture as well as tail injury to  
106 establish the relationship between these in the early stages of tail biting outbreaks.

107

## 108 **2. Material and methods**

109 Before the study, the Animal Experiments Inspectorate evaluated the research protocol  
110 and decided that the study could be conducted in accordance with the guidelines of the  
111 Danish Ministry of Justice Act no. 382 (June 10,1987) and Act no. 333 (May 19, 1990),  
112 726 (September 9, 1993) and 1016 (December 12, 2001) with respect to animal  
113 experimentation and care of animals under study.

114

### 115 *2.1 Experimental design, animals and housing*

116 The study was carried out at a commercial Danish farm from November 2016 to February  
117 2017. The experimental design included four treatments differing in type of enrichment  
118 material: straw on the floor (straw), haylage in a ball of metal mesh (haylage), sisal rope  
119 with a sweet-tasting block (rope) and control treatment (no intervention). To comply with  
120 Danish legislation on permanent access to manipulable and rooting materials, each pen

121 was equipped with two wooden sticks hanging in a chain as manipulable material and dry  
122 feed in a dispenser as rooting material.

123 The experiment was designed to compare the prevalence of tail biting outbreaks in  
124 control pens with each treatment where extra enrichment material was added to the pen.  
125 The number of control pens was therefore double the number of treatment pens. The  
126 treatments were initiated at pen level when at least one pig in a pen was observed with a  
127 tail wound. The sequence of the four treatments was randomized at the start of the  
128 experiment, and then followed the same order.

129 The subjects were 1,804 undocked DanAvl crossbred ((Landrace x Large White) x  
130 Duroc) weaner pigs (7 to 30 kg) from three farrowing batches with 590 to 617 pigs per  
131 batch. Pigs were born in a loose house farrowing system (for pen design see, Pedersen et  
132 al. (2015)). Iron injections (Uniferon, Pharmacosmos, Holbæk, Denmark), [grinding of the](#)  
133 [tip of the needle teeth](#) (Tandsliber proff, Hatting, Horsens, Denmark) and [surgical](#)  
134 [castration of male piglets took place on day three or four after birth. Male piglets were](#)  
135 [given analgesic just before castration \(Melovem® 5 mg/ml\).](#)

136 From the piglets were about 14 days old they were offered solid creep feed on the  
137 floor. [Piglets had access to the straw that the sow pulled from a straw rack.](#) Two days prior  
138 to weaning, piglets were ear tagged and their sex noted. According to the piggery's  
139 production report, the lactation period was 28.4 days. At this point the pigs were  
140 transported to a weaner facility close to the sow unit.

141 The weaner facility consisted of eight rooms of which three were used in the  
142 experiment. Each room had 26 or 30 pens evenly distributed on each side of an inspection  
143 aisle, and 20 or 21 pens in each unit were included in the experiment. A total of 60 pens  
144 were included in the study. Pens measured 4.85 × 2.18 m (length × width) with 7.1 m<sup>2</sup>

145 solid floor towards the wall and 3.5 m<sup>2</sup> cast iron slatted floor towards the aisle. A 2.16 m<sup>2</sup>  
146 adjustable covering was placed above the lying area of the solid floor. Two adjacent pens  
147 shared a dry feed dispenser with two nipple drinkers (MaxiMat, Skiold A/S, Sæby,  
148 Denmark). In addition, a drinking bowl was placed next to the feed dispenser. Each pen  
149 was equipped with two wooden blocks hanging in a chain just above the floor, but without  
150 touching the floor. Pens were daily provided with approximately 400 g (one scoop) of fine  
151 chopped straw (Easy Strø, Dansk Dyrestimuli, Nykøbing Mors, Denmark) on the solid floor  
152 irrespective of treatment.

153 The ventilation system was based on negative pressure air flow from wall air inlets  
154 in one side of the building (SKOV A/S, Glyngøre, Denmark). At piglets' arrival, the room  
155 temperature was 24°C which was gradually lowered to 19°C on day 42. Thermostatically  
156 controlled floor heating pipes in the lying area led to a floor temperature on arrival of 30°C,  
157 which was turned off 14 days later.

158 Upon arrival at the weaner facility, pigs within batch were sorted by size with 29.6  
159 (SD 0.56) pigs per pen with an average gender distribution within pen of 51% castrated  
160 males and 49% gilts (minimum-maximum: 31%-69% castrated males). Three different  
161 home-mixed compound diets (ad libitum access) were provided from 7 to 30 kg. The diets  
162 were formulated to fulfill the nutritional requirements of pigs of this age and genotype.  
163 Phase one diet allocated from 6-10 kg (19.4 % crude protein) consisted of 55.0 % wheat,  
164 22.0 % Danstart 225 Vilomix (Vilomix, Mørke, Denmark), 10.0 % barley, 9.0 % fish meal  
165 and 4.0 % soy oil. Phase two diet allocated from 10-15 kg (18.2 % crude protein) consisted  
166 of 48.0 % wheat, 25.0 % barley, 14.7 % toasted soy bean, 6.8 % premix of mineral and  
167 vitamins (MIN 27600, Vilomix, Mørke, Denmark), 3.0 % fish meal and 2.5 % soy oil. Phase  
168 three diet allocated from 15-30 kg (19.0 % crude protein) consisted of 48.8 % wheat, 24.5

169 % toasted soy bean, 20.0 % barley, 4.5 % premix of mineral and vitamins (MIN 27603,  
170 Vilomix, Mørke, Denmark) and 2.2 % soy oil. Shifts in diets were gradually carried out over  
171 a 7 or 14 days period, depending on the age of the pigs. The onset of a diet shift  
172 depended on the average body weight of pigs in the pen.

173 A stock person monitored the pigs' health once a day in the morning, and, when  
174 needed according to the herd veterinarian recommendations, pigs with clinical signs of  
175 disease were treated with antibiotics. Unthrifty animals and pigs with severe tail lesions  
176 (more than half the tail missing or swelling as sign of infection) were moved to hospital  
177 pens.

178

## 179 *2.2 Tail posture at pen level*

180 Three times weekly (Monday, Wednesday and Friday), the number of standing pigs, tail  
181 posture and tail damage were recorded from outside the pen according to table 1 until at  
182 least one pig were observed with a tail wound. Before recording tail posture, the observer  
183 went into the pen, got every pig up, walked outside the pen and did the recordings.

184

185 Table 1 about here

186

## 187 *2.3 Clinical examination of tails at individual tail scoring*

188 When one pig with either a scabbed wound on a hanging tail, a tucked tail or a fresh  
189 wound irrespective of tail posture was observed, all pigs in the pen were tail scored  
190 according to the scoring system presented in Lahrmann et al. (2018) (Table 2). A wound  
191 was defined as a clear puncture of the skin with tissue damage as in Lahrmann et al  
192 (2018) with a severity of at least a 'wound' (Table 2). After tail scoring one of the four

193 treatments, based on a random predetermined order, was allocated to the pen. From the  
194 day of the early intervention and until a tail biting outbreak, tails were scored three times  
195 weekly. A tail biting outbreak was defined as four pigs with a tail wound irrespective of tail  
196 length and wound freshness. The pen left the study if a tail biting outbreak occurred, and  
197 extra enrichment material, beyond what was used as treatments, was added to stop the  
198 tail biting behaviour.

199 If a pig was continuously observed chewing/biting the tail of the pen mates during formal  
200 inspection, it was removed from the pen and the pen left the study.

201

202 Table 2 about here

203

#### 204 2.4 Treatments

205 When one pig (day 0) was observed with a damaged tail or a tucked tail during the three  
206 weekly tail scorings, one of four treatments was randomly allocated to the pen; straw,  
207 haylage, rope or control (no intervention).

208 In pens with straw treatment from day 0, approximately 200 g of chopped wheat  
209 straw (cut during harvest in the combine harvester) were provided daily during the morning  
210 hours on the solid floor (approximately 7 g per pig per day).

211 In the haylage treatment from day 0, ryegrass haylage was provided in a spherical  
212 cage with a diameter of 30 cm (<https://heuballferkel.jimdo.com/>) made of metal bars  
213 hanging in the middle of the pen above the solid floor approximately one meter from the  
214 slatted floor. The ball was placed at a height enabling pigs to pull out material from the  
215 bottom, and it was gradually lifted as pigs grew. The spherical cage was refilled once daily

216 with approximately 650 g of haylage, and no material was left in the cage the following  
217 day.

218 In the rope treatment, sisal rope (diameter; 20 mm) with a sweet block hung in the  
219 same location as the spherical cage. The 650g sweet-tasting block with apple flavor  
220 (Likit™, [www.likit.co.uk/treats-toys/horse-licks/](http://www.likit.co.uk/treats-toys/horse-licks/)) was placed on the rope at pig head level.  
221 According to the manufacturer, the Likit™ block was composed of glucose syrup,  
222 dextrose, ground safflower seed and blue-green algae extract. Rope was pulled through  
223 the block leaving 30 cm of rope lying on the floor. To keep the block in place, two round  
224 wooden discs were placed beneath and above the block and a knot was tied on the rope  
225 on each side of the wooden discs. A coil of rope hung above the pen, and every second  
226 day, if no rope was lying on the floor, new rope was pulled from the coil leaving 30 cm on  
227 the floor. If pigs consumed the Likit block, a new block was placed on the rope once. If the  
228 block was consumed again, no new block was added, but rope was still renewed as  
229 described.

230 In control pens, no new or additional material was provided on the day, when at  
231 least one pig in a pen was observed with a tail wound (day 0).

232 Of the 60 pens included in the study, an early intervention was performed in 44  
233 pens. In these 44 pens, one of four treatments were provided: Straw on floor (10 pens),  
234 haylage in a spherical cage (8 pens), rope with a sweet block (7 pens) or no extra material  
235 (control, 19 pens). Pens with a tail biting outbreak on the intervention day were not evenly  
236 distributed between treatments, giving the inequality in number of pens provided with  
237 straw, haylage or rope. The extra material was provided until the pen left the study, either  
238 due to a tail biting outbreak (four pigs with a tail wound) or because pigs were moved to  
239 the finisher location at approximately 30 kg live weight after 6.5 weeks.

240

## 241 *2.5 Statistical analysis*

242 Statistical analyses were performed in SAS Enterprise Guide 7.1 (SAS Institute Inc., Cary,  
243 NC, USA) using Generalised Linear Mixed Model procedure (GLIMMIX) with a significance  
244 level of  $P < 0.05$  and pen as the experimental unit.

245 In the statistical model analysing for differences in prevalence of tail biting  
246 outbreaks (binomial distribution) the control group was compared to each treatment (straw,  
247 haylage or rope). Treatment and age at intervention were included as fixed effects and  
248 batch as random term.

249 At pen level, the correlation between percentage of hanging tails and tail damaged  
250 pigs recorded on the same day at the first five recordings after the intervention day (day 0)  
251 was analysed using GLIMMIX. To ensure homogeneity of variance, the variable number of  
252 tail damaged tails was square root transformed. Recording day after intervention and age  
253 at intervention were included as systematic effects, whereas pen was included as a  
254 random effect. Data presenting the correlation between hanging tails and tail damage had  
255 the best fit to a curve based on quadratic equation. The correlation between numbers of  
256 tail damaged pigs in pens with 0, 10, 20, 30 and 40 percentage hanging tails was  
257 estimated and is presented in Figure 1. Results are presented as back-transformed least  
258 square means including 95% confidence limits.

### 259 3. Results

260 In total 44 out of the 60 pens entering the study was included in the analysis. In two pens,  
261 no tail injured pigs were observed through the study period. [The distribution of tail scores](#)  
262 [on the day of the early intervention is listed in Table 3.](#) In 14 pens, there was a tail biting  
263 outbreak (four or more pigs with a tail damage) on the intervention day, and an early  
264 intervention could therefore not be conducted in these pens. In the 44 pens with an early  
265 intervention, 1.7 pigs per pen (SD 0.74, range 1-3 pigs) had a tail damage on the day of  
266 the intervention. The first tail damaged pig in a pen was observed on average 13 days (SD  
267 10.2, range 2 - 42 days) after weaning. During the experimental period from 7 - 30 kg, no  
268 pigs had to be removed to a hospital pen due to tail biting. In pens with a tail biting  
269 outbreak, the biting behaviour was ceased either by giving extra enrichment material or by  
270 removing the biting pig. A biter was removed from one control pen ten days after the first  
271 pig was observed with tail damage. No pigs, neither victims nor biters, had to be removed  
272 due to tail damage in pens with an early intervention.

273 [Table 3 about here](#)

274

#### 275 3.1 Early intervention and tail biting outbreaks

276 A tail biting outbreak developed in one pen with haylage, in two rope pens and two straw  
277 pens (five pens in total), [Table 4.](#) The risk of a tail biting outbreak was significantly lower in  
278 pens with haylage and straw compared with control pens ( $P<0.05$ ). There tended to be  
279 fewer tail biting outbreaks in rope pens compared with control pens ( $P=0.08$ ).

280 [Table 4 about here](#)



281 In total, a tail biting outbreak developed in 18 pens (Table 5), and in 62% of the  
282 control pens with outbreaks, the outbreak developed within two to five days after the first  
283 pig/pigs with tail wounds were recorded.

284 Table 5 about here

285

### 286 3.2 Tail posture and tail damage

287 At pen level, the number of pigs with tail damage was positively correlated with the number  
288 of pigs with a hanging tails ( $F_{1,195} = 7.97$ ;  $P < 0.01$ ) (Figure 1). Significantly more pigs had a  
289 damaged tail in pens with 20, 30 and 40% hanging tails compared with pens with 0% and  
290 10% hanging tails.

291 Figure 1 about here

292

## 293 4. Discussion

294 To our knowledge, this is the first study to investigate the effect of allocating extra  
295 enrichment material after the first tail damage is observed to try to prevent a tail biting  
296 outbreak. Providing the enrichment material as an early intervention, just when the biting  
297 has started, ensures high novelty of the material, which increases attractiveness (Studnitz  
298 et al., 2007). Using manipulable materials as an early intervention measure instead of as a  
299 permanent preventive measure might increase the materials effect on tail biting due to  
300 increased attractiveness. This may further imply that less material or other kinds of  
301 materials can prevent tail biting outbreaks when used as an early intervention measure but

302 not when used as a permanent preventive measure. However, the results should be  
303 interpreted with some caution because it was a minor study.

304 In previous studies, permanent access to various amount of straw has demonstrated  
305 to reduce the risk of a tail biting outbreak (20 g/weaner pig on the floor and 5 g/weaner pig  
306 in a straw rack (Zonderland et al., 2008), 150 g/finisher pig (Larsen et al., 2017) and deep  
307 straw (5 cm) (Van de Weerd et al., 2006). In a review by D'Eath et al. (2014), different  
308 amounts of straw were ranked according to its relative preventive effect. Based on  
309 comparison of relatively few studies, this ranking suggests that small or larger amounts of  
310 straw seemed to prevent tail biting to almost the same extent. However, this ranking may  
311 be influenced by different definitions of tail biting across studies. In the present study a  
312 small amount of chopped straw, allocated daily just when the biting started, reduced the  
313 prevalence of tail biting outbreaks. A reason for this positive effect could be that the  
314 current environment and the possibility to explore influenced the development in tail biting  
315 behaviour to a greater extent, than earlier experiences with enrichment materials, as  
316 discussed by Van de Weerd et al. (2005) Additionally, and based on a minor study,  
317 Zonderland et al. (2008) reported that a small amount of straw provided twice daily  
318 stopped the biting in outbreak pens to the same extent as removing the biter.

319 Giving haylage in an elevated spherical cage probably increased the time the material  
320 was present in the pen compared to giving it on the floor. The material disappeared less  
321 rapidly through the slat openings, and probably this allocation method also increased the  
322 time pigs spent interacting with the material (pulling it out of the cage and  
323 exploring/chewing the material on the floor) (D'Eath et al., 2014). Earlier findings reported  
324 that straw in a rack reduced damaged tails to a greater extent than unchangeable  
325 materials (Van de Weerd et al., 2006; Zonderland et al., 2008), but straw in a rack was

326 ranked lower across studies compared to straw on the floor (D'Eath et al., 2014). However,  
327 the accessibility of material (rack design) and the material presented in the rack probably  
328 influences the preventive effect on tail biting.

329 Sisal rope with a sweet-tasting lick block hanging in the middle of the pen did not  
330 reduce the risk of a tail biting outbreak compared to control pens. However, the result  
331 should be interpreted with caution as it was a minor study. In a review, ranking the  
332 attractiveness of enrichment materials, rope was ranked lower than straw (Studnitz et al.,  
333 2007). This could explain rope's non-significant effect on tail biting. Our casual  
334 observations suggested that the time pigs spent interacting with the material (not  
335 recorded) was spent on exploring the rope, rather than licking the sweet taste block, even  
336 though pigs do have a preference for sweet taste (Day et al., 1996). The preventive effect  
337 of the rope might have been improved if the rope itself had had a sweet taste, thereby  
338 combining sweet taste with a destructible material.

339 A common slurry system is the vacuum based system where the slurry is sucked out  
340 through pipes. In these systems, larger amount of litter material can block up the system  
341 as discussed by D'Eath et al. (2014). In the current study, intervention treatments were  
342 maintained until pigs were moved to the finisher facility. Causal observations indicate that,  
343 in pens with haylage, the slat openings near the solid floor were blocked, and the farmer  
344 had difficulties getting the material sucked through the slurry pipes. From a practical point  
345 of view it would, therefore, be relevant in future studies to investigate for how long the  
346 material should be present to put a stop to the tail biting behaviour. However, removing the  
347 material might redirect pigs' behaviour and trigger the tail biting behaviour to start again  
348 (Munsterhjelm et al., 2009).

349 Research indicates that upcoming tail biting outbreaks can be predicted based on  
350 changes in tail posture from curly to hanging (Zonderland et al., 2009; Lahrmann et al.,  
351 2018). Our results support these findings. We found that an increase in hanging tails was  
352 correlated with increasing number of damaged tails. However, the correlation was only  
353 evident when 20% or more of the tails were hanging at pen level. No difference in number  
354 of tail damaged pigs was observed in pens with pigs with 10% and 0% hanging tails. This  
355 is in agreement with Lahrmann et al. (2018), reporting approximately 15% hanging tails in  
356 pens not close to a tail biting outbreak. Overall, this indicate that other elements aside from  
357 tail biting also affect tail posture as discussed by Larsen et al. (2016).

358 Of the 60 pens entering the study, 14 pens had to be excluded (23%). In these pens,  
359 on the day when the first pig was observed with a tail damage, at least four pigs had a tail  
360 wound (tail biting outbreak definition). No severe outbreaks developed between the three  
361 weekly recording days, but we did miss the beginning of the tail biting behaviour in some  
362 pens. To detect tail damages, as an indicator of tail biting behaviour, just when it has  
363 started, tails should be checked at least once a day.

364 In control pens with no intervention, the development in tail damage was recorded until  
365 a tail biting outbreak. In 42% of the control pens (8 pens), a tail biting outbreak occurred  
366 within two to five days after the first pig was observed with a tail damage. In contrast, a tail  
367 biting outbreak did not develop during the study period in 32% of the control pens (6 pens).  
368 In comparison, the transition from one tail damaged pig to a tail biting outbreak was  
369 between half a week and 12 weeks in a finisher study (Statham et al., 2009), while in a  
370 weaner study the transition from bite marks to a tail wound was in average 7.5 days (SD  
371 5.4 days) with a large variation between pigs (Zonderland et al., 2008). The transition time  
372 from one tail damage to a tail biting outbreak probably depends on the definition of a tail

373 biting outbreak. In the present study, the definition of a tail biting outbreak was four tail  
374 damaged pigs (14 % of the pigs/pen) irrespective of the freshness of the wound. In  
375 Zonderland et al. (2008), at least two pigs (20% of the pigs/pen) should have tail damage  
376 with one being a fresh wound. In Statham et al. (2009), they distinguished between  
377 underlying outbreaks (signs of tail biting observed during formal inspection) and severe  
378 outbreaks (blood in pen and severe damage on at least two pigs, 6.7% of the pigs/pen).  
379 However, the variation in transition time from one tail damaged pig to a tail biting outbreak  
380 indicates that a solitary tail damage does not always develop into a tail biting outbreak.  
381 This is supported by a study, reporting that in 43% of the pens with tail damaged pigs, one  
382 pig was observed with a tail wound without further escalation of the tail biting behaviour  
383 into a tail biting outbreak (Zonderland et al., 2008).

384 Time spent getting every pig up and observe damaged tails from outside the pen was  
385 not monitored. However, it is estimated that it took one to two minutes per pen including  
386 writing down tail posture and tail injury as reported in Lahrmann et al. (2018). If tails were  
387 to be checked in this way during the daily health monitoring, it would, in addition to the  
388 time spent providing extra material, take roughly 30 to 60 seconds per pen.

389

## 390 5. Conclusion

391 An early intervention with provision of a small amount of straw on the floor or haylage in a  
392 spherical metal mesh cage reduced the risk of tail biting outbreak compared to control  
393 pens with no intervention. In comparison, the use of rope with a sweet block as an early  
394 intervention did not reduce tail biting outbreaks significantly compared to pens with no

395 [intervention](#). The results should, however, be interpreted with some caution due to the  
396 relatively small sample size.

397 In control pens with no intervention, a tail biting outbreak developed in 42% of the  
398 pens within two to five days after the first tail damage was observed. In 32% of the control  
399 pens a tail biting outbreak never occurred. This indicates that tail biting behaviour did not,  
400 in every case, escalate from one tail damaged pig into a tail biting outbreak.

401 Even though this was a small study, the results suggest that tail biting outbreaks can in  
402 many cases be prevented by giving the pigs access to extra enrichment material, when the  
403 first minor tail damage is noticed. Therefore, a thorough regular inspection of tails and the  
404 use of early interventions could be one way to reduce the prevalence of tail biting  
405 outbreaks and by it the need for tail docking.

406

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416

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475

476 **Table 1** Tail posture and tail damage

Tail posture/ tail damage	Description
Tail posture	
Curly	Tail is up and curly
Hanging	Tail is down and hanging relaxed alongside the rear end of the pig
Tucked	Tail is down and pressed against the rear end of the pig
Hanging tails – tail condition <sup>1</sup>	
Intact tail	Hanging tail with no visible change in colour as a sign of a tail wound
Scabbed wound on tail end	The tail end is black and covered with a scabbed wound
Bleeding tails	
Bleeding wound	Tails with a fresh wound irrespective of tail posture

<sup>1</sup> Tail condition was only scored on hanging tails. Scoring the tail condition (wound or not) on tucked tails from outside the pen was not possible.

477

478



479 **Table 2** Tail injury scoring system used in the present study and in Lahrmann et al. (2018)

Tail scoring	Description
Damage severity	
No	No visible tail lesions. Earlier lesion is healed
Minor scratches	Minor superficial scratches
Wound	Visible wound and tissue damage
Wound – tail end will fall off	The outer part of the tail has almost been bitten off. During healing tail tip will fall off
Wound freshness	
Intact scab	The wound is covered with a hard-dry scab
Not intact scab	The wound is covered with a scab, but cracks in the scab and dried blood/ fresh tissue are visible
Fresh wound – weeping	Skin is broken, no scab, no blood – only weeping
Fresh wound – bleeding	Fresh lesion and fresh blood are visible
Tail length	
Intact	Full length tail
Outer part is missing	The outer part of the tail is missing
More than half is missing	More than half of the tail is missing
< 1 cm left of the tail	Less than 1 cm of the tail is left
Swelling	
No	No swelling
Yes	Swollen red tail indicating an infection

480

481 **Table 3** Tail damage frequency and distribution (%), broken down by damage to intact  
 482 tails, and damage when part of the tail is missing on day 0 (day of early intervention) in 58  
 483 pens.

Tail score	Early intervention day	
	No.	%
No tail injury	1,534	89.4
Intact length and...		
Scratches, intact scab	10	0.6
Scratches, scab not intact	1	0.06
Scratches, fresh/ bleeding	5	0.3
Wound, intact scab	109	6.4
Wound, scab not intact	12	0.7
Fresh wound, not bleeding	5	0.3
Fresh wound, bleeding	38	2.2
Outer part of tail is missing and...		
Wound, intact scab	0	0
Wound, scab not intact	1	0.06
Fresh wound, not bleeding	1	0.06
Fresh wound, bleeding	0	0
Intact, outer part of tail will fall off	0	0
Total*	1,716	100

---

\* Some pigs were moved to hospital pens or euthanized between weaning and day 0

484

485

486 **Table 4** The number of pens with an early intervention, the number of pens with a tail  
487 biting outbreak and the average number of tail damaged pigs per pen on the intervention  
488 day (day 0) and on the day of the tail biting outbreak (SE).

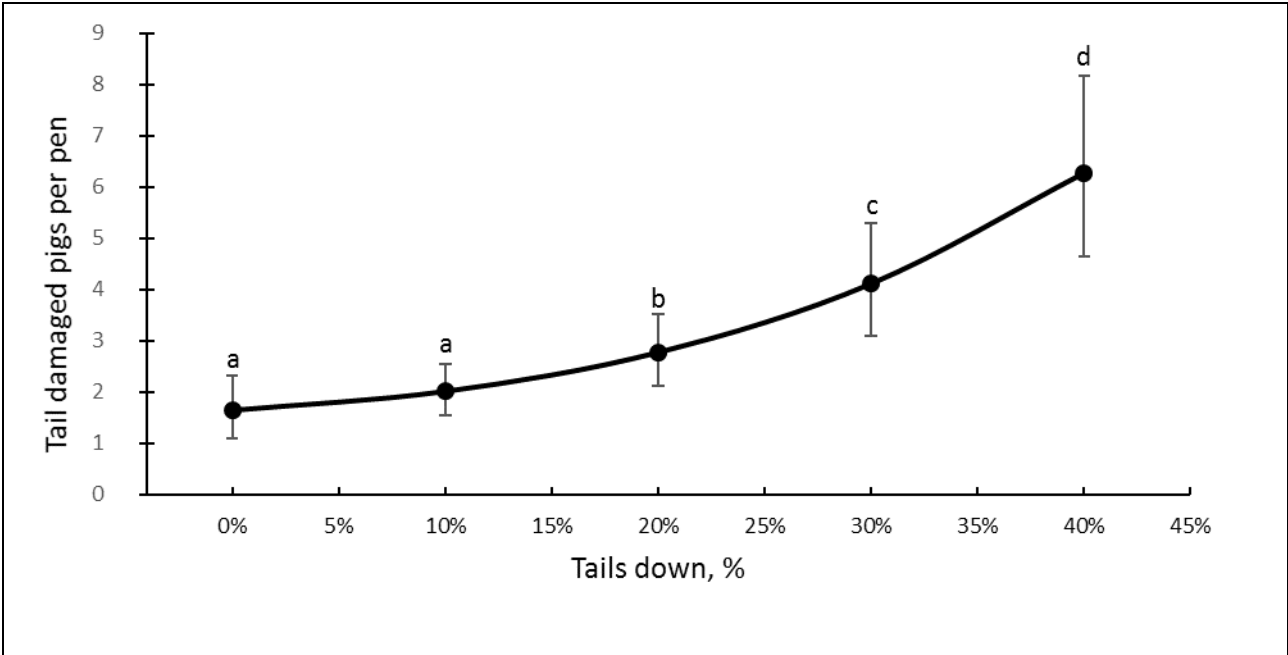
	Intervention				P-value		
	Control	Straw	Haylage	Rope	C x S	C x H	C x R
Number of pens, n	19	10	8	7	-	-	-
Tail damaged pigs, day 0	1.7 (0.73)	1.5 (0.71)	1.4 (0.52)	2.1 (0.9)	0.22	0.45	0.46
Pens with tail biting outbreak, n	13	2	1	2	-	-	-
Pens with tail biting outbreak, % of pens <sup>1</sup>	73 (18.3)	15 (14.6)	8.9 (10.9)	28 (23.8)	<0.05	<0.05	0.08
Tail damaged pigs per pen on the day of the outbreak, n	7.4 (6.0)	15.5 (14.9)	4.0	4.5 (0.7)	-	-	-

489 <sup>1</sup> The P-value in the overall F-test of differences between interventions was 0.03 (F=3.48). Data is presented  
490 as LS-means.

491 **Table 5.** Tail biting outbreaks at pen level within group. Listed according to days after  
 492 intervention.

Tail biting outbreak, day after intervention						
Intervention	2-3	4-5	6-7	8-10	>10	Total
Straw		1			1	2
Haylage	1					1
Rope		2				2
Control	6	2	1	1	3	13

493



**Figure 1** Plot of the percentage of tails down (back-transformed least square means) against the average number of tail damaged pigs per pen within the first ten days after intervention (n=255). Different superscripts indicate significant difference of  $P<0.001$ .

494

## AUTHOR DECLARATION TEMPLATE

We wish to confirm that there are no known conflicts of interest associated with this publication and there has been no significant financial support for this work that could have influenced its outcome.

We confirm that the manuscript has been read and approved by all named authors and that there are no other persons who satisfied the criteria for authorship. We further confirm that the order of authors listed in the manuscript has been approved by all of us.

We confirm that we have given due consideration to the protection of intellectual property associated with this work and that there are no impediments to publication, including the timing of publication, with respect to intellectual property. In so doing we confirm that we have followed the regulations of our institutions concerning intellectual property.

We further confirm that any aspect of the work covered in this manuscript that has involved either experimental animals or human patients has been conducted with the ethical approval of all relevant bodies and that such approvals are acknowledged within the manuscript.

We understand that the Corresponding Author is the sole contact for the Editorial process (including Editorial Manager and direct communications with the office). She is responsible for communicating with the other authors about progress, submissions of revisions and final approval of proofs. We confirm that we have provided a current, correct email address which is accessible by the Corresponding Author and which has been configured to accept email from: [hla@seges.dk](mailto:hla@seges.dk)

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